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## Development and Application of Optical Stimuli in Controlled Atmosphere Transmission Electron Microscopy

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Electron microscopy has been used extensively to characterize nanostructures for decades [1]. Adding *in situ* capabilities to electron microscopes opens for characterization of materials under more realistic working conditions. However, maintaining electron microscopy performance during *in situ* studies is challenging [2,3]. Here, we discuss the development of sample holders capable of exposing samples to optical irradiation, as well as the microscope performance during *in situ* experiments.

As an example, cuprous oxide ( $\text{Cu}_2\text{O}$ ) has been identified as a promising catalyst for the hydrogen evolution reaction from ethanol-containing aqueous solutions. However,  $\text{Cu}_2\text{O}$  suffers from photocorrosion in the presence of water. Fig. 1 shows the photoinduced degradation of  $\text{Cu}_2\text{O}$  to metallic copper during *in situ* exposure to water vapor and light in the electron microscope. The oxide-to-metal transformation is investigated using complementary electron microscopy techniques [4].

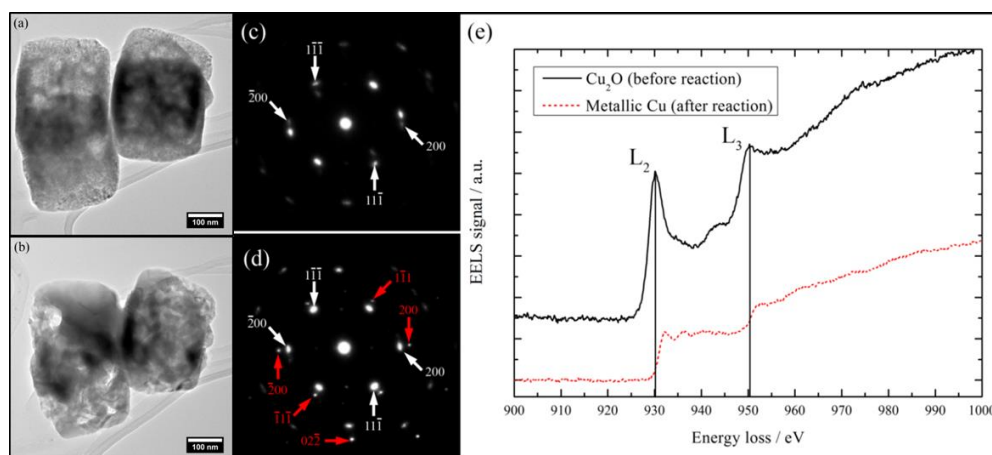


Figure 1: Bright-field images, electron diffraction and electron energy-loss spectra showing the photodegradation of  $\text{Cu}_2\text{O}$  under optical illumination in an aqueous environment.

[1] T. W. Hansen and J. B. Wagner, ACS Catal. 4 (2014) 1673.

[2] J. B. Wagner, F. C. Cavalca, C. D. Damsgaard, L. D. L. Duchstein and T. W. Hansen, Micron 43 (2012), 1169.

[3] Controlled Atmosphere Transmission Electron Microscopy. T. W. Hansen, J. B. Wagner (Eds.), Springer, 2016.

[4] F. C. Cavalca, A. B. Laursen, B. E. Kardynal, R. E. Dunin-Borkowski, S. Dahl, J. B. Wagner, and T. W. Hansen, Nanotechnology 23 (2012), 075705.